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ABSTRACT

This paper describes the development and current state of videodisk technology in Canada. The first section focuses on the technology itself, i.e., the disks, disk players, and the possibilities they offer for interaction between learner and machine. The current costs of the technology and the probable effect of these costs on the market are also discussed. The second section reports on a survey of the research and production of videodisks in Canada, and includes a discussion of the contents, educational design, costs, and features of projects completed by ACCESS Alberta, the Univesity of Alberta in Edmonton, Simon Fraser University in British Columbia, and the Ontario Institute for Studies in Education, among others. Issues involved in most of the projects include: (1) the effective design of interactive learning programs; (2) coordination of the team producing the videodisk; and (3) cost of the technology both to produce and to use. It is concluded that, although the potential of the educational videodisk is widely recognized in Canada, its wide acceptance as a valid, affordable alternative for educational delivery is still open to question. A list of contact individuals and references is included. (DB)

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NEW TECHNOLOGIES IN CANADIAN EDUCATION

PAPER 13

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EDUCATIONAL VIDEODISC IN CANADA

By Judith Tobin

Study Coordinator
Ignacy Waniewicz

January 1984

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Paper 2	Communications and information technologies in Canadian elementary and secondary schools
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Paper 14	Educational teleconferencing in Canada
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Paper 17	New technologies in education in Canada: Issues and concerns

Copies of these papers can be purchased from TVOntario, Box 200, Station Q, Toronto, Ontario, Canada M4T 2T1.

FOREWORD

We dedicate this series to its designer and director, Ignacy Waniewicz. His death on February 21, 1984, has left us with a feeling of immeasurable loss.

With uncanny intelligence, instinct, and energy, Ignacy introduced the first educational television programs in his native Poland in 1957 and rose to the position of Director of Educational Broadcasting. During the mid-1960s, he served as a Paris-based program specialist in the educational use of radio and television, working for UNESCO in Chile, Cuba, Ivory Coast, Upper Volta, Mexico, Egypt, Nigeria, Senegal, Ghana, Great Britain, United States, Switzerland, and Israel. Ignacy shared the experience and insight he gained from this work by teaching and writing in Polish, German, Russian, Hebrew, Spanish, French, and English. His achievements are widely recognized in the broadcasting and academic communities on four continents.

As Director of the Office of Development Research at TVOntario, Ignacy explored his farsighted and consuming interests in adult education, media literacy, television as a primary tool for lifelong learning, and most recently, the educational uses of new technologies. His work did much to shape and guide TVOntario's progress over the last 15 years.

It is with love and respect that we dedicate this series to Ignacy Waniewicz. In its enormous scope, its thorough documentation, its emphasis on concrete results, and its concern with educational issues, this series reflects both Ignacy's vision and his intellectual legacy.

Donna Sharon
for the Office of Development Research

Preface to the Series

NEW TECHNOLOGIES IN CANADIAN EDUCATION

These papers in the series "New Technologies in Canadian Education" are the result of an international commitment. In June 1980, the Third Conference of Ministers of Education of Member States of the European Region of UNESCO adopted a recommendation requesting the member states to carry out joint comparative studies on well-defined problems of common interest in education. At a subsequent meeting of the European Region National Commissions for UNESCO, 14 subjects were agreed on for joint studies.

The theme "New Technologies in Education" was selected as study #11. The 17 countries participating in the study are Austria, Belgium, Denmark, Finland, France, Hungary, Italy, the Netherlands, Poland, Spain, Sweden, Ukrainian SSR, USSR, United Kingdom, as well as Canada, Israel, and the U.S.A. who are also members of the UNESCO European Region. At the first meeting of the national coordinators from these countries, held in October , 1982, at the University of South Carolina in Columbia, South Carolina, U.S.A., a plan was adopted for the study. In the first phase of this plan, the individual countries are to report on the ways in which the new technologies are being used in education. (A brief outline of the international design is available on request.)

The Canadian Commission for UNESCO was requested to coordinate, on an international level, the first year of the study. We are grateful to the Canadian Commission for selecting TVOntario, and the Office of Development Research (ODR) to be in charge of this task. The ODR was also asked to coordinate the Canadian contribution to the study, with financial support from the Department of the Secretary of State. We gratefully acknowledge their assistance.

In preparing the Canadian review of the use of technology in education, the ODR contacted a number of educators, academics, government officials, administrators in educational communications organizations, and others, across the country. It became apparent that there was a strong need for a well-documented account of the uses of both the "older" technologies (e.g., film, audio, television) and the newer technologies (e.g., computers, videodiscs, videotex) in the complex Canadian educational system.

Early in 1983, several types of research activities began simultaneously: designing instruments to gather information from each type of institution or interest group, identifying uses and users of each type of technology, and exploring the areas where Canada's distinctive features predispose toward technological developments. The 17 papers listed on the back of the title page emerged as a result.

Information for these papers was provided by hundreds of individuals expressing their own views or reporting on behalf of educational institutions and organizations, government departments, public and private corporations. We extend to them our sincere thanks.

I would like to acknowledge the contribution made by Thelma Rosen who assisted in the development of the inquiry instruments and played a major role in the gathering of this information. The task of supervising the final editing, production, and distribution of the papers was assigned to Donna Sharon. Her resourcefulness and persistence have contributed greatly to the completion of this series. Sharon Parker typed most of the papers from the initial drafts to their final versions. Her dedication made it possible to complete the study in such a relatively short period.

While the preparation of these papers has been supported by the Canadian Commission for UNESCO and the Department of the Secretary of State, the papers' contents do not necessarily reflect the official views of either party on issues related to technology in education.

Ignacy Waniewicz
Study Coordinator
Director
Office of Development Research
TVOntario

January 1984

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INTRODUCTION

The videodisc is a new technology that can combine the advantages of audiovisual media, computer-assisted instruction, and control by the learner of his or her own learning. The discs, which resemble silver phonograph records, are played on special videodisc players, and the information is displayed on a television screen. Videodiscs are available for both education and entertainment. This paper concentrates on the educational applications.

The videodisc is a visual medium, and any type of visual image can be stored on a videodisc and displayed when the disc is played. On one disc, motion and sound can be combined with text, still graphics, photographs, facsimiles of documents, and any other visual medium. If the disc is used only for linear motion sequences, each side can hold approximately 30 minutes. If only still frames are put on the disc, up to 54,000 still frames can be stored on each side. Moreover, motion and stills can be stored on the same disc, in various combinations. For example, 10 minutes of motion leaves storage space for about 32,000 still frames.

The audio capacity of most discs and disc players includes two separate sound channels. On discs of concerts and films, the two channels are usually used together to provide stereo sound. For educational purposes, they can be listened to separately: one channel, for example, could contain a narration in French and the other, in English. Explanations for beginning and more advanced learners could be put on different channels, and the learner could choose the appropriate channel.

Some videodiscs contain computer programs directly on the disc, which are then accessed through the microprocessor built into the player. Players may also be interfaced with a separate microcomputer, thereby facilitating full computer control of the videodisc. In the second example, a computer program can be stored on a floppy or hard disc rather than on the videodisc itself. The learner uses the computer program to interact with the videodisc and with the computer, which would provide for an individualized, self-paced, visual, audio, and computer-based learning experience. That is the promise of the videodisc in education - to combine older

technologies in the delivery of learner-centred, interactive instruction.

In the United States, industry and the military have produced and used videodiscs for training. Educational institutions have been more cautious, but several are experimenting with videodisc technology. In Canada, the experimenting has been slower, and most of the activity has consisted of investigations and pilot projects.

This paper will seek to explain the available technology and the development of discs that has taken place in Canada.

The first section is devoted to the technology - the discs, the players, and the possibilities they offer for interaction between learner and machine. The current costs of the technology and the probable effect of these costs on the market are discussed.

The second section concentrates on educational applications. It begins with a survey of the videodiscs that have been produced in Canada and the research that has gone into them. The contents, the educational design, the costs, and the unique features of each of the projects are described. A discussion of the future of the disc as an educational tool completes the paper.

THE VIDEODISC SYSTEM

The discs

Two main types of videodiscs have been developed - the capacitance, or contact, and the optical, or laser.

In the production of an optical disc, a low-level laser beam encodes the information from the videotape onto the disc's surface in a series of microscopic marks. The disc is covered by two layers of plastic. While the disc is being played, a laser beam is reflected to a mirror, which reflects the light to the decoder, which translates it back to the original audio and video signals. This is a reflective optical videodisc. There is also a transmissive optical videodisc that allows the light beam to pass through the disc, thereby enabling both sides to be read without turning the disc. As there is no physical contact between the surface of the disc and the laser to cause deterioration, the quality of the signal remains constant.

The optical disc can be recorded in two formats: Constant Linear Velocity and Constant Angular Velocity. Constant Linear Velocity (CLV) is limited to linear playback. Since the content is stored on the disc without "addressing" the location of each visual frame, specific visuals cannot be accurately located. A CLV disc can contain 60 minutes a side. In the Constant Angular Velocity (CAV) discs, each frame is given a unique "address," and so any one of the 54,000 frames can be accessed quickly and accurately. The address for each frame is located in the part of each disc called the vertical blanking interval. When asked to do so, the videodisc player can locate and display any frame almost instantaneously. For example, it can move from the first frame to frame 54,000 in less than five seconds. It is this particular capacity of the CAV disc that allows the development of interactive learning systems. Each disc can facilitate hours of learning because the individual learners can control their own progress through the disc by their speed and by the choices they make.

The capacitance system uses a stylus to read the information that is electronically encoded on the disc, much as a needle picks up the sound from a phonograph record. The electronic signals are stored in tiny pits located in grooves

on the disc. With this type of disc, the stylus touches the disc while the disc is being played. Eventually the disc is damaged and the signal deteriorates. In the Fall of 1983, RCA Inc., the major producer of capacitance discs and players, began to market the interactive capacitance disc. The new product offers the freeze-frame capacity and accurate random access essential for interactive learning. However, the majority of capacitance discs have been made for the entertainment market, that is, for the nonstop viewing of a movie or concert.

A variation on the capacitance system, called Video High Density disc (VHD), was introduced in April 1983 in Japan. This system has a broader stylus and a flat, grooveless disc. The stylus sweeps across the densely packed field of micropits. The lack of grooves and broader width of the stylus reduce the wear on the disc and stylus, thus giving them a substantially longer life.

At this point, some limitations to videodisc technology should be mentioned. The capacitance and optical videodiscs are not interchangeable; that is, each must be played on its specifically designed player. The optical discs from Sony are playable on Phillips, Hitachi, Universal, and Magnavox players, and vice versa. Incompatibility lies in the inability of the players to read each other's computer codes completely, so the interactivity would not be possible. This lack of compatibility is a constant source of frustration to purchasers.

The technology for erasing and re-recording discs is not yet widely available, although a system has recently been developed by Matsushita in Japan that allows multiple recordings and erasures on a single disc. The availability of this technology will overcome one of the main disadvantages of the videodisc, especially as compared to the videocassette. The ability to change part of the information on a disc will allow the updating that can extend the educational shelf-life of a videodisc. An erasable, re-recordable disc will also be more saleable in the entertainment market. Educational videodiscs are developed primarily in subjects that are not constantly changing, but the impossibility of revising, removing, or, updating information is still a disadvantage.

Specialized facilities have been established by the principal manufacturers of videodisc systems in order to produce a "master" of the discs. The first step is to put all the visual and audio information on a one-inch or three-quarter-inch premaster videotape. Special codes and signals must also be on the videotape to serve as cues for the disc's interaction. The premaster videotape will then be subject to a "simulation," in which all of its components are tested for accuracy and completeness.

Mastering is not the only method of producing discs. A technology, not yet commercially available, called Direct-Read-After-Write (DRAW), is used to produce optical digital discs. These can store information in digitized (computer readable) format, up to 12.5 billion characters of information on a single 30-centimetre diameter disc. In the DRAW process, a laser is used to write the information on the disc. A read-head follows the writing laser to check the accuracy of the recorded data. The DRAW process has a much lower error rate but a higher cost per copy when compared to stamping the copies. If an error is found, that part of the disc can be disabled and the information rewritten. The greatest potential of the digital disc is in information storage and retrieval. However, this application of videodisc technology is not extensively explored in this study, which concentrates on the videodisc for teaching and learning.

The players

A number of different control features have been built into various models of videodisc players. The use of the disc is limited by the player on which it is played - the models designed for the industrial and educational markets allow for greater flexibility. Conversely, the format of the disc determines the uses that can be made of the player; for example, the disc must be formated in Constant Angular Velocity to take full advantage of random search and other capacities.

The technical capacities of the disc player allow the learner to control and vary the speed at which information is presented by the disc. The following description is based on

the optical disc player designed with the educational market in mind. Its features include:

Freeze frame. Videodisc players can freeze any one of the 54,000 frames into a still picture. The learner can obtain this freeze-frame effect in motion sequences by stopping the action, or an automatic picture stop can be programmed into the disc to ensure a freeze frame for text, photographs, or whatever information the disc designer has chosen to present in freeze frame. Because nothing but a beam of light comes into contact with the surface of the optical disc while it is being played, one frame can be displayed indefinitely with no harm to either player or disc.

Step motion. The learner can command the player to move from one freeze frame to the next. The step motion can go forward or backward.

Slow motion. The player repeats a frame a specific number of times before moving on automatically to the next frame. The rate of slow motion can vary from normal speed to step motion, and forward or backward according to the user's wishes.

Fast motion. This may be in forward and reverse, to create the effect of fast motion up to three times normal speed.

Scan. Scanning is similar to skimming a book. The learner can skip over several frames at a time, displaying only a few of them.

Frame address. Each of the 54,000 frames is given a code number which is stored in the vertical blanking interval and can be displayed as required on the monitor.

Chapter address. The disc can be divided into segments called chapters. This code is entered in the vertical blanking interval.

Search. This is the random access function. The learner can enter the number of the frame or chapter desired, and the player will search for and display it accurately in a matter of seconds.

Skip/review. Skip tells the player to jump ahead to the next chapter. Review performs the opposite procedure by returning to the beginning of the chapter or to any other chapter.

Dual-channel audio. All optical videodisc systems are capable of reproducing dual-channel audio. The two channels can be played simultaneously to reproduce stereo sound, or they may contain different information and be played individually.

Still frame audio. Through the use of digital, compressed audio, the audio capacity of the videodisc has been increased to 15 hours of real-time play back on a single disc side. This system, introduced by Sony in the Spring of 1983, means that 1,400 video still frames can be accompanied by up to 40 seconds of audio each. The figures are variable as less audio would allow the inclusion of more still frames.

These technical capabilities of videodisc players help to make videodiscs responsive to the learner's choices. It is also possible to link the players to a microcomputer, thereby greatly extending the possibility of interaction between learner and machine. The levels of interaction are the subject of the next section.

Levels of interaction

Four levels of interaction are possible.

Basic level. At the basic level, only the linear playback is used. The disc, which can be CAV or CLV, is played from beginning to end, with no scheduled interruptions or restructuring of content.

Level one. The videodisc player at this level has a control panel or a detachable key pad for remote control, which the learner can use to command step motion, freeze frame, forward and reverse play, scan, and fast and slow motion. The learner can choose to go directly to any chapter or frame desired. The player can also be made to stop automatically when it comes to picture stop codes or chapter stop codes on the disc. This level exploits the mechanical possibilities of the players.

Level two. Level-two interaction is made possible through the use of industrial or educational videodisc systems containing programmable microprocessors. Computer programs can be entered into the player's memory (usually 1K) by digital codes carried directly on the disc. Some programming is also possible manually by using the keyboard.

The computer program codes on the disc are carried on the second audio channel and are automatically dumped into the player's microprocessor. The program can structure the learner's use of the disc or can be used to question and guide the learner.

Level three. At level three, one or more disc players may be interfaced with an external computer. The computer programs can be stored on separate floppy or hard discs, and, therefore, be virtually unlimited in memory or versatility.

Programs can be made quite complex, and the computer can be programmed to keep track of the learner's answers. Information in the computer, such as explanations, questions, and graphics can be displayed for the learner. The computer keyboard allows the learner to do mathematical problems, answer open-ended questions, or address the computer in complete sentences. Light pens, joy sticks, paddles, and touch screen can all be used for input.

Level three may use two monitors - one to display the information from the videodisc and the other to display the information from the computer. In an advance on level three, an interface is used that allows information from both sources to be presented on the same monitor. The disc and computer images can be presented alternately, or the computer graphics and text could overlay the information from the disc. For example, a map of Europe could be displayed from the videodisc and the learner could enter a year (e.g., 1921) and the computer could superimpose the names and boundaries of countries on the map.

This flexibility can create multiple learning systems on one videodisc. Using the same visuals, the computer could overlay explanations and graphics at different knowledge levels, in different languages, for instruction, and for testing. Computer overlay capacity is not new but the technology, the visual resolution, the graphics capacity, and the variety of type fonts are all improving.

New disc formats, new players, new interfaces, new systems are constantly being developed and released. The number of manufacturers is growing and includes several major companies such as Sony, Hitachi, 3M, Pioneer, RCA, Matushita, NV Phillips, Thomson-CFS, and McDonnell Douglas. In fact, the predominance of hardware and the lesser emphasis on software and on educational applications may be leading to an imbalance. This will be considered in a later section.

Costs and their implications

The simplest videodisc system consists of a videodisc player and a monitor for display. Prices for the linear-only capacitance player can be as low as $250.* The industrial and educational models, however, can cost approximately $3,000, although the prices are dropping. The microcomputer and interfaces for level-three interaction will vary according to the model and the peripherals chosen. To establish an integrated system with computer and player, plus appropriate system software, could cost more than $5,000. There are also extensions like the voice synthesizer to allow voice input and output, touch screen, joy sticks and light pens for input, which would greatly increase the price as well as the capacity for interaction with a learner. The discs available in the education market cost between $20 and $70 to purchase.

The costs of producing the discs are also high. The variable costs are those for the production of the premaster videotape. The videotape must be elaborately cued to produce the still frames, random-access ability, automatic stops, and other cues on the videodisc. A common estimate is that production costs for a half-hour premaster videotape will be one-and-a-half to three times as much as for a standard half-hour videotape production.

Added to those costs are the charges for mastering and stamping the discs. There are quite a few companies that have the equipment to master videodiscs. Although the prices vary, an average cost for preparing a master is $2,500; the cost of each copy depends on how many are ordered. These

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*All prices are in Canadian funds.

figures are for level-two interaction. However, the price is decreasing as the technology improves and the competition increases. If 500 copies of a disc were stamped, the cost per disc including mastering would be approximately $28.

The present costs limit the number of institutions that are able to purchase videodisc players. It must also be remembered that interactive programming allows only one student to use a player at a time. One of the criteria for purchase will be the availability of suitable educational discs. Since the cost of producing discs is also high, the producers are a rather select group. Industrial and military trainers have been the largest users of videodiscs and consequently they have done or commissioned much of the disc production. Those users concentrate on mechanical training, technical instruction, and other in-house uses. Educational institutions and research groups have produced discs for children, for different levels of academic learning, and for games, but these are less plentiful.

Consequently, the purchases of videodisc players and systems have reflected the pattern of disc production. A few elementary and secondary schools may have received players as part of a pilot project, but few in Canada have bought them. Some research in Canada has taken place in universities, and some discs have been produced - but very few universities have actually purchased equipment for instructional use. The community colleges have been slightly more active in buying and using videodiscs because discs suited to their purposes are more readily available and because, in some cases, they have received donations of equipment.

EDUCATIONAL APPLICATIONS

Videodiscs in Canada: Production and research

Both educational institutions and private industry have been involved in videodisc production and research in Canada. This section describes some of these projects. The emphasis is on the educational application of videodiscs, although some studies on the use of discs as storage and retrieval media are mentioned.

ACCESS Alberta, the provincial agency, has produced three videodiscs and is planning another. The Alberta Vocational Centre took part in the production of a videodisc on sign language "Let Your Fingers Do Your Talking" and one on urinary catheterization for nursing assistants. Both were developed at level two of interaction - that is, using the 1K of memory built into some videodisc players. The third disc, designed to be accessed with an Apple microcomputer, was funded by the Department of the Alberta Solicitor General. The thirty-minute "Cell Search" for correctional officers cost only $6,000 to produce. The print information from a manual was adapted to the microcomputer, and a switcher was developed to facilitate moving between the video and computer monitors. ACCESS may produce a fourth disc, which would be an experimental disc on English as a second language. The language instruction would be through instruction in developing life and work skills. The dual-audio capacity could contain two levels of language to make the disc more flexible.

At the University of Alberta in Edmonton, the Faculty of Education is working on a project called SIMCLASS, which is to provide a simulated teaching experience for education students before their exposure to the actual classrooms. The first program was designed, using a videocassette recorder and a microcomputer, to give future teachers of French as a second language experience in dealing with students who give wrong answers. The second used a videodisc and an Apple microcomputer to train teachers of reading in elementary schools. The student teacher prepares his or her own questions on the story of King Midas and the Golden Touch and enters them on the keyboard of the microcomputer. As each question is entered, the videodisc displays students giving replies. The answers may be right or wrong. The student

teacher must then make some reply to the student. Another disc is being developed to deal with classroom discipline in the secondary school. A situation will then develop according to the strategies that the student teacher uses.

The videodisc technology was chosen for the SIMCLASS project because of its frame-accurate freeze-frame capacity and its improved search time. The project itself is designed to move the student teacher beyond the lecture to a simulated classroom where he or she must respond, but is also able to stop and think. The first disc is being pilot-tested. There are questions about the cost of producing and mastering videodiscs: i.e., at what point does the saving of instructors' time make videodiscs cost-effective?

In the Spring of 1982, the Banff Centre for Continuing Education in Alberta produced a twenty-minute videodisc that provides training in the use of the wheelchair for people with left hemiplegia (paralysis). It can be used by patients or those who work with them, and has been distributed to hospitals and university nursing faculties. The mechanical capacities of the videodisc player were used fully in the design. The user can use the slow motion, freeze frame, chapter, and frame search commands to view and review the disc. This disc was produced as a pilot project using the facilities of the Banff School of Fine Arts.

The videodisc project at Simon Fraser University in Burnaby, British Columbia, entailed the design and field testing of an experimental videodisc entitled, "How Your Heart and Circulatory System Works." A variety of audiovisual material (motion, graphics, still frames, charts, and printed pages) were included to exploit the multidimensional capacities of videodisc. A field test was done with the elementary school children and the teachers for whom the disc was developed. The disc is to be used for health education in Coquitlam School District.

The field test showed some interesting results. The teachers were enthusiastic about the technical options on a videodisc - varying speeds, freeze frame, and random access. The disc was rated as superior to other audiovisual aids, particularly for versatility. The elementary school students enjoyed using and learning from the videodisc. In fact, the interactive testing was one of their favorite parts of the

experiment, seemingly because they enjoyed manipulating the machine and the nonthreatening test.

The Ontario Institute for Studies in Education (OISE) in Toronto, Ontario, is conducting extensive research and development in videodisc technology. The first disc that the OISE group developed was for the training of machinists on the techniques of single-point thread cutting. It has been developed, tested, and pressed for use in apprenticeship training in secondary schools and community colleges. In a field test, the two-week retention rate with the interactive videodisc was 93 per cent; with a classroom instructor, the tested retention was 43 per cent. A second level of the thread-cutting disc, which will have a manipulable image of the machine on the screen, is being considered.

In Ontario, the Ministry of Natural Resources has funded a training disc on forest fire control, produced by OISE, which will be field-tested in the Fall of 1983. This production includes mostly stills and text frames, with text taken from a manual. It is estimated that it will provide five hours of learning time and will cost under $25,000 to produce.

The OISE group has received funding from the Ontario Board for Industrial Leadership and Development for three further discs. Each of them is to be a prototype in the exploration of the interactive possibilities, learning styles, and the identification of production problems in interactive training with a videodisc. Specifically, the topics of the discs will be: oscilloscope training for community college students, using simulation and a touch screen; economic geography, a tutorial for secondary school students; and transformation geometry as an adventure game for grades 7 - 10. Each disc produced by the OISE group has the computer program stored on the video channel, thereby eliminating the need for separate floppy discs while providing a fully interactive learning experience. This technological development allows the contents of up to 256 floppy discs to be stored on a single videodisc.

Another Toronto group with videodisc experience is a private firm, Interactive Image Technologies (IIT). Among the discs they have produced is one on Canadian Indian culture which can be accessed by chapter for linear viewing in either French or English. The same firm has also produced

an educational game in which viewers' decisions about ways of living can lengthen or shorten the life of the person on the television screen. Another lifestyle disc asks questions about users' sports and fitness preferences, and then suggests resources available in Ontario. The audio tracks have been used to produce a bilingual (French and English) disc. In an information kiosk at a Toronto shopping centre, a videodisc produced by IIT is part of a system that gives shoppers information concerning products and services in the mall.

In an application using technology to teach about itself, IIT has developed an interactive videodisc for showing computer novices how to use an IBM personal computer. This disc is available for public use in locations such as the Ontario Science Centre and Ontario Place in Toronto. IIT is now working on a more advanced version, which will combine the computer, the videodisc player, two monitors, voice synthesizers, and other technologies to introduce the use of such computer programs as VISICALC, WORDSTAR, and other programs on the IBM-PC (personal computer).

The first and most prolific producer of videodiscs in Canada is Michael J. Petro Ltd. of Windsor, Ontario. This firm is involved in the continuing production of the training discs for General Motors (GM) and American Motors. The General Motors discs were initially prepared for both sales and mechanic training for GM's 10,000 dealerships in the United States. Petro Ltd. has produced completely new discs for the 600 GM dealerships in Canada. Some of these discs have been offered to trade and technical schools to enhance the instruction in such topics as repair of automobile sound systems, reconditioning, acrylic finish repair, and basic electrical troubleshooting. The discs are all interactive, using the capacity of the microprocessor in the videodisc player. The Petro firm has also designed and programmed an external computer interface program, but at this time the program is limited to their in-house use for designing, analyzing and simulating during the production phase. Michael J. Petro Ltd. has completed more than 40 projects, involving both production and research on interactive video, primarily in industrial training and product introduction.

Sheridan College of Applied Arts and Technology in Oakville, Ontario, is exploring the educational applications of interactive video - both tape and disc. Sheridan has been

experimenting with the use of Telidon protocol for videodisc graphics. The graphics available from Telidon are of a higher quality and are more versatile than the microcomputer-generated graphics; they are more effective as graphic overlays on the video image from the disc (for further information, see Paper 11). The objective is to store a Telidon graphics database in an Apple microcomputer and use it for creating overlays on the disc. (Similar work is being done by the OISE group.) Since Sheridan lacks some of the more elaborate production equipment, it is working with limited resources and with low cost as a prime objective.

One of the videodisc projects underway at Sheridan is the production of a disc on introductory anatomy. It may be possible to put an entire first-year college course on a two-sided disc. The information will have broad applicability to nursing, physiotherapy, and kinesthetics. Various institutions may wish to use selected chapters rather than the entire disc. Sheridan would like the disc to be educationally useful beyond the college itself.

The development process entails producing a prototype of a unit on videotape. The unit will include a wide variety of interactive media - the keyboard, light pens, workbooks, acetate tracing - and will be tested extensively to determine which media are the most effective for learning. The Telidon graphics overlay capacity will also be integrated. Even 3-D graphics are being considered.

An application of videodiscs in research has been pilot-tested at the Public Archives of Canada in Ottawa, Ontario. The videodisc was considered a possible solution to the archivists' most pressing problem - to protect the original material while making its information readily available. The massive storage capacity of the disc, its relative stability over time, and the possibility of computer-based, rapid random access were the reasons for the pilot project. The material selected for disc storage covered the range of archival holdings - maps, architectural drawings, paintings, medals, woodcarvings, positive and negative image photographs, letters, treaties, minutes of meetings, audio, and film. The pilot project, although not trouble free, succeeded in establishing the videodisc's storage and display capacities.

The National Library of Canada in Ottawa, in consultation with Michael J. Petro Ltd., has also produced an experimental interactive disc. The project was designed to demonstrate the ability of the videodisc to store and present library materials in a variety of formats, the information retrieval capability of a combined videodisc and microcomputer system, and the use of the videodisc as a practical research tool. Four different productions were put on the disc. Two were chosen from films and slide-shows already available in order to experiment with adapting existing material. The third was a film tour of the National Library. The fourth production was the most challenging of all: various types of still material were collected to illustrate the history of the National Anthem "O Canada." The sound, in French and English, is from recordings of the anthem starting in the nineteenth century. The disc can be accessed by using the various indexes programmed into it or by the frame-search capacity of the built-in microprocessor. An Apple II Plus microcomputer is used to store and retrieve the bilingual index of over 4,000 terms, and to integrate the index with the stills stored on the disc.

Both education and research capabilities are being studied by such departments of the federal government as Consumer and Corporate Affairs, National Defence, Fisheries and Oceans; the National Research Council, and the National Film Board. Much of the current educational experimentation is in exploring the validity of the interaction by using videotapes and slides with microcomputers. The visuals may then be transferred to videodisc, if it becomes financially feasible.

A Canadian authoring language, NATAL II, has been developed by the National Research Council of Canada and Honeywell Ltd. The language is constructed so that subject matter experts with no experience in programming computers can quickly learn to design computer-based learning programs. Honeywell is using NATAL II as the authoring language and has already prepared videodiscs purchased from other sources to design new interactive learning systems.

The production and use of videodiscs have been considered and discussed in many institutions, but the actual experimentation is limited. The universities and colleges have expressed some reservations about videodiscs: they consider the price to be very high and they wonder whether

the current technology will last; they also have doubts about the quality of the software, its acceptance by learners, and the general availability of suitable courseware. The technical capabilities and educational potential of the videodisc, particularly when linked with a microcomputer, are exciting to educators, but many practical problems must be solved before the videodisc can be used widely in the educational system.

Summary of the issues

When computer-assisted instruction (CAI) was first developed, it was heralded as a major advance in teaching. Educational television was initially greeted with the same enthusiasm. But a more critical assessment of those two media has led to the recognition that they have many shortcomings. Educational television is thought to be too passive because the learner has no control over it. CAI enables students to learn at their own speed and to correct themselves, but the disadvantage, aside from a lack of strong visuals, is the quality of computer software itself. Many educators have been disappointed in the quality, the flexibility, and the availability of CAI programs. Videodiscs, which combine television and CAI, can be a victim of the weakness of both these media - or they can combine their promised strengths.

The use of visuals does not guarantee the students' attention - much less their continued commitment once the initial impact fades. Tedious, badly designed, unsuitable, or confusing computer-assisted instruction is no more palatable when accompanying a videodisc than it is by itself. No new solutions to this problem are suggested, except those that can be offered by careful design and hard work.

Designing interactive learning. Many of the issues in the development of videodiscs focus on the design of effective interactive learning. Bill Olivier of the Ontario Institute for Studies in Education has said, "The main concern should be the production of the learning experience. The key is interactive training, not the videodisc per se." A problem can also arise from the versatility of the videodisc. "The challenge is to abandon the linear design of educational materials and develop an interactive learning system" (Glenn

Kirchner, Simon Fraser University). The possibilities for the videodisc are so broad and the imagination of the designer can be so narrow that the interactive possibilities may never be fully explored (Joseph Koenig, Interactive Image Technologies). In a videodisc design, the computer-based learning and the visuals must each be effective; they must also work together in a cohesive learning package.

What are the most effective methods for learner interaction? What is the right combination of visuals, text, questions, and learner reinforcement? What are the most suitable colors, type faces, and layout on the television? Those are all unanswered questions in the design of interactive videodisc. There can never be absolute answers, as decisions must also depend on the subject matter, but research should be able to provide some direction. The educational uses of videodiscs have not been evaluated extensively enough to provide guidelines for the development of videodiscs.

Research like that being conducted at Sheridan, OISE, the University of Alberta, and other institutions is studying the possibilities for videodiscs to interface with computers and learners to interact with videodiscs - to find the methods that are most effective in an <u>educational</u> sense. "The videodisc is a most effective educational distribution system, but only if the developers are willing to utilize what it can do for learning" (Michael Petro, Michael J.Petro Ltd.).

A further challenge to the designers is inherent in the nature of the interaction between learner and machine. In the classroom, a teacher can treat each student as an individual with learning strengths, moods, and personal needs. A machine can never respond to the individual in a truly human fashion. However, by means of artificial intelligence, a computer can ask questions that take many individual differences into consideration. The ability of the computer to process large amounts of information about each learner and use it to respond to his or her needs and preferences can be a mixed blessing. The number and the complexity of the variables that could be considered in designing an interactive videodisc are overwhelming. Designers must decide which factors about the learner (as an individual) they will incorporate in the disc, and at the same time determine the content-related structure.

The team that must be assembled to produce a disc is another design issue. The project team should include a producer, an instructional designer, a subject matter expert, a script writer, a computer programmer, a systems analyst, an evaluator, sometimes a graphic artist, and other support personnel. As there are few people with experience in designing videodiscs, the team members must be given time to understand the new medium and to decide how their talents can best be combined. Somehow, the talents must be coordinated and balanced, so that no one area or ability dominates the production, to the detriment of the learning.

Very little training for the team members is available in Canada. A program in courseware design was started in the Fall of 1983 at Sheridan College in Oakville, Ontario, and interactive videodiscs are specifically discussed in the course on interactive media. The Banff Centre for Continuing Education offers instruction in the development of innovative techniques for education. This program integrates four types of literacy: perceptual, instructional, computer and technological - the necessary components for the design of interactive video, as well as other media (Milton Fruchtman, Banff Centre).

A final issue for designers may, in fact, be more an issue of redesign. The basis for this is a view of the disc as a massive database of appropriate visual information that could be accessed by instructors or instructional designers to suit their own individual needs (Michael Barnes, Sheridan College). The way of accessing the visuals is through instructional materials stored on magnetic discs that can be changed to suit the needs of the designer, the teacher, or the students (Frank Paine, Honeywell). The videodisc can be seen as the "hard data" which cannot be revised or erased. The computer link provides the "soft data" which can be modified for different audiences and can select which visuals are displayed. The standardized information on the videodisc can be localized and individualized by interaction with a computer program. It is the relationship between hard videodisc information and flexible computer information that holds the promise (Harv Honsberger, Sheridan College).

Serious consideration could be given to writing new interactive programs for the relatively inexpensive-to-purchase discs, rather than constantly producing new ones at great expense. Educators can become active in the redesign

of videodiscs, assisted by programming languages, graphics packages, and other aids designed especially for the non-technician. "The videodisc offers an advancement that many teachers have previously only dreamed about - a complete interactive system which is inexpensive and durable enough for teachers to begin their own videodisc libraries suited to their respective areas of expertise" (Glenn Kirchner, Simon Fraser University).

Technology as an issue. The decision to develop a videodisc should begin with the conviction that learning can be facilitated by the use of the disc. The development of a disc as the prime goal can lead to the subordination of the learning goals to the technology. Many of the researchers think that the technology has already taken precedence over the learning design. Joseph Koenig (IIT) thinks that many of the discs now available demonstrate too clearly that the developers are emphasizing all the wrong things - the hardware rather than the interaction. The continual development of hardware has produced an overdependence on it instead of leading to the creation of exciting possibilities for learning.

The opinion that there has been too much development of hardware was also expressed by Glenn Kirchner of Simon Fraser University. He thinks that software development is being held back and, as the ultimate value of the medium is in the software, the future of the videodisc will suffer. Some development of hardware and interface capabilities is necessary, especially if inadequacies are revealed during production, but in many cases, the technologists rather than the educators have dominated the design team. The results have been technologically impressive but educationally weak.

Canadian researchers are not entirely satisfied with the technology now available. There are many "if only" attitudes toward technology - if only it were cheaper, erasable, compatible, etc. It seems that those most closely involved with disc production spend much of their time trying to overcome weaknesses they encounter in the technology. On the larger scale, they are unhappy with the concentration on technological advancement in the industry as a whole. This contradictory state of affairs might be corrected by better communication among Canadian developers concerning their problems and solutions. However, the fact remains that many

of those involved with videodiscs feel that too much attention to the technological razzle-dazzle has resulted in too little attention to the educational product.

Costs. In the preparation of a videodisc, some of the variable costs are the sophistication of the production, the amount of original footage shot, and the level of interaction. The costs are also affected by the additional informational and technical difficulties in preparing and cuing the "perfect" videotape premaster. Most pilot projects are not interested in cost-effectiveness, but they are very conscious of the high price of videodisc production. Bill Olivier at OISE gave the figure of $10,000-per-hour of student-learning time as production costs for an original, fully interactive disc (i.e., if a disc provides the average student with 10 hours of interactive learning, production costs will be about $100,000).

Joseph Koenig of IIT suggests that the cost of producing a videodisc will be one-and-a-half to three times the cost of producing a normal videotape. This figure is similar to that given by many American producers.

Although production and mastering are both high-cost factors of videodiscs, savings can be made eventually when multiple copies are pressed. The cost per copy drops on volume orders, unlike reproduction costs for film and videotape. Consequently there might be an eventual payback of production costs if enough copies were sold (Harv Honsberger, Sheridan College).

David Mappin, University of Alberta, has carefully considered the cost implications of the videodisc in the area of staff/student ratios. "Having instructors spend less time with one group of students if the students are involved with high quality, individualized interactive learning experiences is one possible outcome. Another is to have one instructor deal with a larger number of students with the same investment of his or her time, and this outcome would seem more probable in today's fiscal climate. The third possibility is not to change the staff/student ratio with the introduction of this technology. This is the approach we have most often used in introducing instructional technology over the past two decades, seeking instructional effectiveness rather than efficiency. I would suggest that

with financing at all levels of education being what it is in the 80's, efficiency will become as important an issue as effectiveness if we are to be successful in using interactive technologies in instruction."

An additional concern is that "because of cost, each disc might become the definitive disc on the subject matter it contains" (Michael Barnes, Sheridan College).

Cost is also linked to design and technology, which have already been discussed. The designing takes time, talent, and careful consideration of numerous variables before a worthwhile teaching tool can result. The technology, rather than being an asset, can hinder the educational promise by absorbing too much of that time and talent. These two issues will only be resolved by continued experience and research.

Use in training. It is expected that the brightest future for the educational videodisc will be in industrial and skill training. There its effectiveness has been proven by many American industries, and particularly by the military. A successful application has been in the fast-food industry, where the problems of high turnover of unskilled personnel needing standardized skills were solved by using videodisc. Lengthy and complex repair manuals have also been put on videodisc for military use. GM and Ford, both in the U.S. and Canada, have made extensive use of videodisc training.

Training discs are not yet widely used in Canada, but the potential is recognized. The bulk of Canada's large "baby boom" population are now in the work force. Technological and social changes demand retraining for employment, and the videodisc could be the delivery system. The high price of training could be reduced, particularly in professional education, industrial training, and motor skills development (Joseph Koenig, IIT).

CONCLUSION

The future of the videodisc in education in Canada remains hard to judge. The disc has great educational promise, and there is useful research and development taking place in Canada. The potential of the videodisc as a technology and as a teaching tool is widely recognized. Many institutions are "considering" discs, but the commitment seems to be missing. There are quite simply not enough high-quality educational discs available to justify an investment in equipment except for experimental purposes. Teachers and learners are unfamiliar with the medium; school boards, universities and colleges have tight budgets; and there is some resistance to new investments and new technologies. The industrial and military training markets that are to some extent "carrying" the videodisc industry in the United States have not yet solidified in Canada.

The educational videodisc seems to be in a classic Catch-22 situation in Canada. There are not enough videodiscs to rationalize the wide-scale educational investment in hardware that would in turn rationalize the development of more videodiscs. The videodisc will not disappear from the educational scene in Canada, but its wide acceptance as a valid, affordable alternative for educational delivery is still open to question.

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